

ABSTRACT

**of the dissertation of Muratov Dosmukhamed Kuatuly on the topic
“Comparative characteristics of growth and development of young dairy
cattle breeds using various feed additives”, submitted for the degree of Doctor
of Philosophy (PhD) under the educational program 8D08201 – “Technology
of Livestock Products Production”**

Relevance of the research topic. The current state of dairy cattle breeding in the Republic of Kazakhstan is characterized by a combination of positive dynamics in gross production indicators and persistent structural constraints that limit the growth of technological efficiency in the industry. According to operational data from the Bureau of National Statistics, as of March 1, 2026, the country had 8.5125 million head of cattle, with 45.8% of the livestock concentrated in household farms, 43.2% in peasant and farm enterprises and among individual entrepreneurs, and only 11.0% in agricultural enterprises. At the end of 2025, Kazakhstan produced 3.755 million tons of cow's milk; however, the average milk yield per dairy cow decreased from 2,524 to 2,506 kg, or by 0.6%. At the same time, the share of dairy cattle in the total cattle population amounted to 49.5%, indicating the high importance of the dairy segment for the sustainability of the entire industry. Thus, the increase in livestock numbers and gross milk production has not yet been accompanied by a comparable increase in productivity and technological uniformity of production.

This contradiction is particularly evident in the raw-material base of the dairy industry. In 2024, Kazakhstan produced 3.577 million tons of raw cow's milk, of which 2.185 million tons, or about 61%, came from private household farms, whereas agricultural enterprises and peasant farms accounted for 1.393 million tons, or about 39%. Such a production structure complicates the formation of a stable flow of standardized raw materials for processing, increases seasonal fluctuations in supply, complicates veterinary and sanitary control, and limits the implementation of uniform technological solutions. Analytical materials based on official statistics additionally indicate a shortage of organized milk collection and cooling infrastructure, as well as incomplete utilization of processing capacities: for certain types of dairy products, capacity utilization in 2023 amounted to only 37.7–58.9%. Under these conditions, improving the efficiency of replacement young stock rearing becomes not merely a specific animal husbandry task, but one of the fundamental conditions for improving the sustainability of the raw-material base of dairy cattle breeding in Kazakhstan.

A key element in addressing this task is the system of rearing replacement heifers at an early age. It is during this period that growth rates, forestomach development, metabolic intensity, and the prerequisites for future milk productivity are established. According to research data, feeding costs remain the largest expenditure item in the rearing of replacement heifers and account for 51% to more than 70% of the total cost of their rearing. At the same time, from a physiological standpoint, early age is the period most sensitive to feeding quality; calves should be stimulated to consume solid feeds as early as possible, because starter concentrate

containing readily fermentable carbohydrates promotes rumen development and development of the ruminal epithelium. A positive relationship has been established between growth intensity during the milk-feeding period and subsequent first-lactation productivity, and maintaining an average daily gain above 0.5 kg/day during this period has also been associated with better first-lactation performance. Current production standards recommend beginning insemination of heifers when they reach 55% of the mature live weight of cows, which for Holsteins usually corresponds to 12–13 months of age, while first calving is planned at 22–24 months. Consequently, the quality of starter feeding is directly related not only to calf growth but also to the economics of herd reproduction.

For this reason, starter compound feed should be regarded not as an ordinary component of the diet, but as a technological tool for managing growth rate and the age at which reproductive maturity is reached. However, for young calves, the issue cannot be reduced simply to lowering feed formulation costs by replacing traditional components with cheaper protein sources. National academic recommendations indicate that when non-milk proteins are used, their amino acid profile must be considered, as well as the balance of potentially limiting amino acids, primarily lysine, methionine, and threonine. A review of the use of soybean protein in young stock feeding shows that the inclusion of soybean ingredients in diets for young calves without sufficient technological processing is often accompanied by deterioration in growth and health indicators due to antigenic and antinutritional factors. This leads to a fundamentally important conclusion: replacement of expensive protein components in starter feeds is acceptable only when the physiological adequacy, high digestibility, and safety of alternative raw materials have been demonstrated.

The need for resource conservation and rational utilization of food-industry by-products further increases the relevance of the problem. According to the Food and Agriculture Organization of the United Nations, 13.2% of food worldwide is lost after harvest and before the retail stage, while a further 19% is lost at the stages of retail trade, food service, and households. A systematic review shows that many food losses and by-products, after appropriate technological processing, possess sufficient nutritional value, can be converted into safe feed ingredients, and in some cases provide feed conversion indicators comparable with conventional diets. For calves, not only high-protein but also functionally active components are of particular interest. A meta-analysis of *Saccharomyces cerevisiae* fermentation products in calves demonstrated improvements in rumen development, immunocompetence, and weight gain, particularly during the period after cessation of milk feeding. In turn, a study conducted in Kazakhstan in 2025 showed that the inclusion in starter feeds of such food-industry by-products as egg powder, feed yeast, and dried whey can improve feed efficiency and individual metabolic indicators in calves, although the magnitude of the effect depends on feeding conditions and the composition of the basal diet. This means that the scientifically substantiated development of locally produced protein starter feeds for replacement young stock of dairy cattle is simultaneously an economically, technologically, and environmentally significant task for dairy cattle breeding in Kazakhstan.

The aim of the dissertation research is to provide scientific substantiation and quantitative assessment of the effects of experimental starter feeds on growth, physiological status, and the economic efficiency of rearing replacement dairy heifers from birth to 15 months of age under the conditions of two farms.

To achieve this aim, the following **objectives** were formulated:

1. To develop formulations of experimental starter feeds, produce experimental batches, determine their chemical composition, and compare them with commercial starter feeds used on the farms.
2. To conduct a scientific and production feeding trial with experimental starter feeds in replacement heifers of the Holsteinized Black-and-White breed on two dairy farms from birth to 3 months of age and to study their effects on growth, development, and feed efficiency.
3. To assess the effects of the diets under study on hematological and biochemical blood parameters of calves up to 3 months of age.
4. To conduct post-experimental observation of replacement heifers up to 15 months of age and determine the effect of the previously used starter feeds on subsequent growth, development, and the time required to reach the target live weight for first insemination.
5. To conduct a comparative analysis of the economic efficiency of the experimental starter feeds, taking into account starter feed cost, cost per unit of live-weight gain, and total costs of heifer rearing.

The objects of the study were replacement heifers of dairy cattle of the Holstein and Black-and-White breeds aged from 0 to 15 months on two farms in the Kostanay Region differing in technological level.

The subject of the study was the effect of experimental starter feeds on the growth, development, physiological status, and economic efficiency of heifer rearing, assessed on the basis of live weight, weight gain, linear body measurements, biochemical and hematological blood parameters, feed conversion, and total rearing cost.

The methodological basis of the study consisted of the principles of standardized feeding of replacement dairy young stock, the recommendations of the National Research Council (2021), as well as domestic and international studies on the development of starter compound feeds and assessment of their effects on calf growth, development, and physiological status. The study was conducted as a scientific and production trial on two farms in the Kostanay Region that differed in housing conditions and basal diets.

The comparative evaluation of the experimental starter feeds was conducted according to the matched-group principle. Diet efficiency was determined using a set of zootechnical, physiological, laboratory, and economic indicators: live weight, linear body measurements, absolute, average daily and relative growth, feed intake and conversion, quality of starter compound feeds, biochemical and hematological blood parameters, age at attainment of breeding weight, feed costs, total cost of rearing a heifer, and cost per 1 kg of live-weight gain.

The methodological framework for statistical data processing was based on the classical methodology of analysis of variance developed by R. Fisher, the

multiple-comparison method of J. Tukey, criteria for assessing distribution normality and homogeneity of variances developed by A. N. Kolmogorov, S. S. Shapiro, M. B. Wilk, and H. Levene, as well as generally accepted principles of biometry in biological and agricultural research presented in the works of N. A. Plokhinsky, J. Zar, R. Sokal, and F. Rohlf. Statistical processing of numerical data was performed using IBM SPSS Statistics 27 and Microsoft Excel.

The scientific novelty of the study lies in the fact that, for the first time under the conditions of two dairy farms in the Kostanay Region, a comparative evaluation was conducted of experimental starter compound feeds developed using processed by-products of food production for rearing replacement dairy heifers. It was established that the effects of the experimental starter feeds on growth intensity, feed efficiency, physiological status, and subsequent development of heifers were farm-specific and depended on housing conditions and basal feeding. New data were obtained confirming the potential of starter feed formulation B, based on inactivated feed yeast and dried milk whey, as a feeding solution for improving the efficiency of replacement young stock rearing.

Practical significance of the research. The practical significance of the dissertation research lies in the fact that, on the basis of the studies conducted, experimental formulations of starter compound feeds for replacement dairy heifers were developed and tested, and recommendations were substantiated for starter selection and determination of calf readiness for cessation of milk feeding, taking into account actual solid-feed intake, growth intensity, and physiological status of the animals.

Under the production conditions of JSC “Zarya” and LLP “Saryagash” in the Kostanay Region, the feasibility of using starter compound feeds containing protein-functional components based on food-industry by-products was established. Starter feed formulation B, based on inactivated feed yeast and dried milk whey, was recognized as the most promising based on the combined zootechnical, physiological, and economic indicators. The effect of this formulation was manifested in increased growth intensity of replacement heifers, improved feed utilization, reduced feed costs per 1 kg of live-weight gain, and attainment of a higher live weight by a reproductively significant age. Under the conditions of JSC “Zarya”, at 15 months of age, heifers receiving starter feed B exceeded animals of the control group in live weight by 12%, and heifers of starter feed A group by 5%. Under the conditions of LLP “Saryagash”, the age at which the weight corresponding to physiological readiness for first insemination was reached was similar among animals of all groups; however, by 15 months of age, heifers receiving starter feed B exceeded their counterparts in the control group and starter feed A group by approximately 6%.

The results obtained allow starter feed formulation B to be considered a potentially promising feeding solution for rearing replacement heifers. This formulation may be of greatest practical interest to farms where technological and feeding conditions limit realization of the growth potential of young stock.

The dissertation research was conducted within the framework of the scientific project of the Ministry of Agriculture of the Republic of Kazakhstan

BR22886157 “Management and rational use of genetic resources of dairy cattle breeds through breeding and molecular genetic technologies”. The work performed corresponded to the objectives of the project and was aimed at addressing current tasks related to improving the efficiency of dairy cattle breeding, including through improvement of technologies for rearing and feeding replacement young stock.

The main provisions of the dissertation submitted for defense:

1. Scientific substantiation of formulations of experimental starter compound feeds containing protein-functional components of animal and microbial origin for replacement dairy heifers.
2. Effects of experimental starter feeds on growth, development, linear body measurements, average daily gain, and feed efficiency of heifers during the milk-feeding period.
3. Farm-specific efficiency of the use of experimental starter feeds under the conditions of two dairy farms in the Kostanay Region differing in the level of basal feeding and rearing conditions.
4. Physiological assessment of the effects of experimental diets on calves based on hematological and biochemical blood parameters characterizing protein, carbohydrate, and lipid metabolism, as well as the functional status of the liver.
5. Economic efficiency of the use of experimental starter feeds taking into account feed costs, costs per 1 kg of live-weight gain, total costs of rearing a replacement heifer, and age at attainment of the live weight corresponding to physiological readiness for first insemination.

Personal contribution of the doctoral candidate to the research. The doctoral candidate directly participated in the development of the research program, formulation of the aim and objectives, analysis of domestic and international literature, development of experimental starter compound feed formulations, and organization and conduct of the scientific and production trial under the production conditions of two farms in the Kostanay Region. The author participated in the formation of experimental groups of animals, recording of feed intake, weighing and linear body measurements, collection of biological material, systematization of laboratory data, statistical processing of the results obtained, and calculation of economic efficiency. The main results, conclusions, and practical recommendations of the dissertation were formulated with the direct participation of the author. The doctoral candidate participated in the preparation of scientific publications, presentations at scientific and practical conferences, and a teaching manual on the research topic.

Description of the main research results. The main results of the dissertation research were presented in scientific publications and proceedings of international scientific and practical conferences and were also used in the preparation of a teaching manual on the methodology of scientific and production trials and biometric data processing in animal husbandry.

One of the main publications on the dissertation topic is the article by Muratov D., Kubekova B., Khassanova M., Smailova M., Naimanov D., Miciński J., Papusha N., “Effects of alternative protein sources from food industry byproducts in starter feeds on dairy calf growth performance under different conditions: a preliminary

study”, published in *Frontiers in Animal Science* in 2025. The journal has an Impact Factor of 2.4 and a CiteScore of 4.0; in the submitted list of publications, the article is classified as Q1 in Scopus, 81st percentile.

Publications recommended by the Committee for Quality Assurance in Science and Higher Education of the Ministry of Science and Higher Education of the Republic of Kazakhstan include works devoted to the development of experimental starter feeds for young cattle based on food-industry waste and to the assessment of the effects of dietary nutritional value on quality indicators of dairy cattle.

Research materials were also presented at international scientific and practical conferences, where issues related to the use of animal-origin food-production waste as feed additives were considered.

In addition, the teaching manual “Experimental Technique and Biostatistics” was prepared in co-authorship. – Kostanay: Non-profit Joint Stock Company “A. Baitursynuly Kostanay Regional University”, 2026. – 138 p. The manual is devoted to the methodology of conducting scientific and production trials and statistical processing of data in animal husbandry using Microsoft Excel and IBM SPSS Statistics.

Publications. Seven scientific works have been published on the dissertation topic, including one article in an international peer-reviewed journal, three articles in peer-reviewed publications recommended by the Committee for Quality Assurance in Science and Higher Education of the Ministry of Science and Higher Education of the Republic of Kazakhstan, two articles in the proceedings of international scientific and practical conferences, and one teaching manual:

1. Muratov D., Kubekova B., Khassanova M., Smailova M., Naimanov D., Miciński J., Papusha N. Effects of alternative protein sources from food industry byproducts in starter feeds on dairy calf growth performance under different conditions: a preliminary study // *Frontiers in Animal Science*. – 2025. – Vol. 6. – Article 1595300. – DOI: 10.3389/fanim.2025.1595300. The journal *Frontiers in Animal Science* has an Impact Factor of 2.4 and a CiteScore of 4.0; in the submitted list of publications, the article is classified as Q1 (Scopus), 81st percentile.

2. Papusha N.V., Muratov D.K., Miciński J. Development of Experimental Starter Feeds for Young Cattle Based on Food Industry Waste // *3i: intellect, idea, innovation – интеллект, идея, инновация*. – 2024. – No. 3. – P. 90–99. – DOI: 10.52269/22266070_2024_3_90.

3. Papusha N.V., Kubekova B.Zh., Muratov D.K., Sokolovskaya-Metla D.S. Effect of Dietary Nutritional Value on Quality Indicators of Cattle // *Ғылым және білім (Science and Education)*. – 2025. – No. 3–5 (80). – P. 87–98. – DOI: 10.52578/2305-9397-2025-3-5-87-98.

4. Muratov D.K., Papusha N.V., Kubekova B.Zh. Effect of Shock Freezing of Colostrum on Immunoglobulin G Preservation and Transfer of Passive Immunity to Newborn Calves // *3i: intellect, idea, innovation – интеллект, идея, инновация*. – 2026. – No. 1. – P. 159–169. – DOI: 10.52269/SRDG2611159.

5. Papusha N.V., Muratov D.K. Comparative Characteristics of Animal-Origin Food Production Waste Used as Feed Additives // *Modern Problems of*

Animal Science: Proceedings of the VI International Scientific and Practical Conference Dedicated to the Memory of Doctor of Agricultural Sciences, Professor Bakytzhan Muslimovich Muslimov. – Kostanay, December 7, 2023. – P. 122–129.

6. Muratov D.K. Effect of Storage Duration on the Nutritional Value of Roughage and Concentrated Feeds in Dairy Cow Diets // *Modern Problems of Animal Science: Proceedings of the VIII International Scientific and Practical Conference Dedicated to the Memory of Doctor of Agricultural Sciences, Professor Bakytzhan Muslimovich Muslimov.* – Kostanay, December 11, 2025. – P. 50–55.

7. Teaching manual “**Experimental Technique and Biometrics**”, Kostanay, Non-profit Joint Stock Company “A. Baitursynuly Kostanay Regional University”, 2026, 138 p.

Volume and structure of the dissertation. The dissertation is presented on 157 pages of typescript and consists of an introduction, literature review, materials and methods of research, results of the author’s own research, conclusion, practical recommendations, list of references, and appendices. The dissertation contains 35 tables, 18 figures, 234 references, and 8 appendices.